

SPECIAL POINTS OF INTEREST:

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SPRING 2010

Food safety risks increase with split marketing

On-farm reduction of Salmonella prevalence in pigs requires the identification of risk factors to direct interventions. This study was designed to determine if split marketing of finishing pigs constitutes a risk factor for Salmonella infections, by comparing Salmonella prevalence in the first group of pigs selected for slaughter ("First pull") versus the prevalence in the last group of pigs selected for slaughter ("Close out") from multiple commercial finishing lots. Nine paired samplings were conducted consisting of matched groups of pigs from individual barns as the "first pull" and the "close out" with a 4-week interval between groups.



From each group, fecal and meat samples were collected, on-farm and at slaughter, respectively. Fecal samples were selectively enriched, and analyzed for the presence of Salmonella, whereas

in Salmonella prevalence was observed, based on both bacteriologic and serologic analysis. Overall, there was an increase of 9.2% in bacteriologic prevalence, and 31.3% in serologic prevalence from "first pull" to "close out" groups. This study demonstrates that a significant increase of Salmonella prevalence occurs between the first and the last group of pigs from a finishing lot shipped to slaughter, with "close out" groups of market pigs posing a higher risk for Salmonella contamination of pork products. Therefore, it is concluded that split marketing is a risk factor for Salmonella infections in finishing pigs.

meat juice samples were analyzed for the presence of antibodies against Salmonella. In 7/9 (77.8%) of the studied barns, an increase

Cow Comfort

This study evaluated the effect of rubber or concrete floors on cow body movement while walking (locomotion) and white blood cell functions and gene expression over the 30 days prior to and after calving. After calving, cows from the concrete flooring were slower than those from the rubber flooring. Cows in their second lactation were slower than those in their first lactation, and this was more predominant in the cows on the rubber flooring. Cows from the rubber flooring had more of two types of white blood cells after calving (perhaps showing less suppression). After calving, more cells of the cows from the rubber flooring had the receptor for gram negative bacteria (such as some pathogens for cattle and humans, Salmonella or E. coli). This suggests that the cells of the cows on rubber flooring may be more responsive to

the environment. However, cows from rubber flooring had greater expression of a gene related to wound healing and the gene associated with pain signals. The ability of the cows from the rubber flooring to activate white blood cells may be indicative of an improved immune response. The roles of the gene for tissue repair and that of the one involved in pain signaling are both still being unraveled for all species. These data show that both of those genes may be important in determining the ability of cattle to respond to environmental stressors. These data are useful for scientists to further elucidate the role of these genes and eventually for producers to determine the potential benefits of investing in rubber flooring that may extend beyond the reduction of incidence of lameness.



Changing Diet to Reduce Aggression

Aggression is a major problem for swine production, negatively impacting the pigs' health and welfare. The neurotransmitter serotonin is essential for aggression control and is synthesized from the amino acid Tryptophan. Dietary approaches to increase tryptophan in the feed in order to raise serotonin availability in the brain and long-term positive social handling have separately been used to reduce stress in pigs. The objective was to determine whether a high-tryptophan diet fed to grower (3-month-old) and finisher (6-month-old) maternal gilts (female pigs for reproduction purpose) would effect their behavioral activity and aggressiveness and to test whether adding social handling, or not would change responses. The work



found that feeding the high tryptophan diet did significantly raise the concentration of tryptophan in the blood at both 3 and 6 months of age. The high tryptophan diet also reduced behavioral activity (alertness, walking, drinking and nosing/rooting the pen) and time spent standing, mostly in 3-month-old gilts, and this dietary effect was most marked in non-handled gilts. The high tryptophan diet decreased the number of fights and overall aggressiveness when fed to the 3-month-old gilts, but had no effect when fed to the 6-month-old gilts. Long-term positive social handling improved growth performance, but had little effect on behavior. Provision of high-tryptophan diet reduced behavioral activity and aggressiveness of gilts, especially at the grower stage, and these results are likely mediated by activation of the serotonergic system in the brain. Inclusion of higher levels of tryptophan in commercial diets would improve swine welfare by reducing aggression.

"Award-winning graduate researchers"



Recent Awards

Dr. Rachel Dennis was the recipient of the Alltech Manuscript Award for her manuscript titled "Serotonergic Mediation of Aggression in High and Low Aggressive Chicken Strains." The paper was part of her Ph.D. research and was coauthored by Drs. Z.Q. Chen and H.W. Cheng. This award is given to a student for the presentation and publication as senior author of an outstanding research manuscript in Poultry Science or The Journal of Applied Poultry Research.



Dr. Rosangela Poletto collected a MidWest ASAS Young Scholar Award at the MidWest section meeting in Iowa in March 2010, where she gave an invited presentation on her Ph.D. research. She also collected both the W.R. Featherstone Outstanding Ph.D. Student award

and the Book-Harmon Leadership Scholarship from Purdue Department of Animal Sciences in May 2009. The Featherstone award is considered an extremely high honor in the Graduate Program and serves to reward excellence whereas the Book Harmon Leadership Scholarship was established in recognition of efforts to provide and promote leadership in animal agriculture.

Lyndsey Jones collected a Purdue Animal Sciences LOUJA Graduate Travel Award which is awarded to Animal Sciences graduate students, presenting outstanding research papers based upon original research and excellence of presentation. Her presentation was entitled "Pen and Stall Housed Sows Prefer Unlocked to Locked Free Access Stalls" and the award enabled her to attend the North American Regional ISAE

meeting in Montreal in July 2009.

Jean-Loup Rault collected the W.R. Featherstone Off-campus Training Fellowship from Purdue Department of Animal Sciences. This fellowship was established to annually provide financial support for a graduate student in the Department of Animal Sciences to attend a formal career development training program, organized workshop, or course off campus. Jean-Loup used his award to travel to the Regional Anesthesia Study Center of Iowa (RASCI) workshop about epidural/spinal catheter placement and ultra-sound guided peripheral nerve blocks, at the University of Iowa



Grants awarded



- **Heng-wei Cheng** and **Don Lay**. USDA-AFRI. \$374,828. "A Model for Pain Mechanisms in Farm Animals: Infrared vs. Hot Blade Beak Trimming and Practical Implications for Laying Hens".
- **Heng-wei Cheng** and **Don Lay**. USDA-Post doctoral Program. \$100,000. "Modification of Serotonergic System for Controlling Feather Pecking and Cannibalism in Chickens".
- Paul Ebner and **Marcos Rostagno**. National Pork Board. \$54,000. "Evaluation of phage therapy administration systems to prevent *Salmonella* infections in swine".
- **Jeremy Marchant-Forde**. Elanco Animal Health. \$11,788. "Impact of Paylean Level and Handling Intensity on Stress Responses of Market-Weight Pigs to a Handling and Transportation Model".
- Michael Boehlje, Michael Schutz, Timothy Baker, Phillip Paarlberg, and **Don Lay Jr.** Purdue University. \$24,928. "Animal welfare/behavior regulations: alternatives and consequences of policy options".
- **Marcos Rostagno**. University of Arkansas. \$64,200. "An integrated systems approach to reduce salmonella in organic and all-natural poultry handling".

Arrivals LBRU Welcomes.....

- **Becky Atkinson-Haley** joined us in Feb 2010 as our new Program Support Assistant. Becky has been working in Animal Sciences at Purdue for the last few years.
- **Jasmine Coe** has joined for the summer of 2010 as a research technician. Jasmine has just completed her B.S. in animal science at Purdue University and will be starting her D.V.M. also at Purdue, in the fall.
- **William DeBoer** joins as a Research Technician to manage Dr. Marchant-Forde's sow aggression project. Bill is also completing his M.S. degree in fish biology at Purdue.
- **Shelly Pfeffer DeBoer** started with the LBRU in Winter 2009, following her B.S. in Animal Science at Purdue. Shelly is working with Dr. Marchant-Forde on behavioral enrichment of the PigTurn housing system.
- **Dr. Rachel Dennis** stays with the LBRU in her new capacity as a Post-Doctoral Scientist. Rachel completed her Ph.D. with Dr. Heng-Wei Cheng examining aggression in poultry.
- **Jason Felver-Gant** began his M.S. studies in August 2009. He received his B.S. in Biology from Roger Williams University in 2007, and then worked in Newport Animal Hospital. He is working with Drs. Cheng and Eicher on heat stress-associated oxidative damage and the effects of antioxidants in chickens.
- **Lyndsey Jones** joins us from Dr. Ed Pajor's lab after his move to the University of Cal-
- gary. Lyndsey holds a B.S. from Purdue and is finishing up her M.S. project on sow preferences for free-access stalls.
- **Laurie Mack** also joins from Dr. Pajor's lab. She holds an M.A. from West Chester University, PA and is working on her Ph.D. with Dr. Don Lay investigating effects of alley width on welfare of sows in free-access stalls.
- **Deng Pan** began his M.S. studies in Fall 2009. His B.S. was earned at Zhejiang University in China. He is studying how heat stress on the dam during gestation affects microbial populations of the dam and her calf and the immunity and health of the calf, with Dr. Eicher and Dr. Rostagno.
- **Dr. Rosangela Poletto** also stays with the LBRU as a Post-Doctoral Scientist. She completed her Ph.D. with Dr. Jeremy Marchant-Forde looking at the effects of dietary additives on aggression in growing and finishing pigs and is now working on the use of heart rate variability as a welfare indicator in pigs.
- **Stephanie Wisdom** joined in May 2009 after completing her B.S. in Animal Science and Psychology at the University of Missouri - Columbia. She is working on gastric ulcers in sows and effects of diet with Dr. Marchant-Forde.
- **Ben Zhang**, began his M.S. studies in Fall 2009. His B.S. was earned at Zhejiang University in China. He is studying pain and the effects of beak trimming in chickens with Dr. Cheng.





LBRU to Host Major Conference

Members of the Unit are playing important roles in the planning of the 45th Congress of the International Society for Applied Ethology, which will be held in Indianapolis between July 31st and August 4th 2011. The ISAE is the major academic society for scientists working in animal welfare science.

Dr. Jeremy Marchant-Forde is chairing the Organizing Committee and Dr. Don Lay is also on the committee, together with colleagues from Purdue and other MidWest universities.

The overriding theme will be "Scientific evaluation of behavior, welfare and enrichment". More specific themes will include:

- Zoo animal behavior, welfare and enrichment

- Laboratory animal behavior, welfare and enrichment
- Engineering environments and measurement technologies for science and welfare
- Pain, distress and humane end-points.

The congress has only been held twice previously in the U.S. in 2001 and 1992. Given the recent increase in public interest in animal well-being within the U.S., the conference will provide timely information about the science behind the assessment of animal well-being on farms, in zoos, in laboratory settings and as companions. More information will be found at www.ars.usda.gov/meetings/ISAE2011 as it becomes available.

Infra-red Beak Trimming

Beak trimming is a common practice in the poultry industry. The purpose of beak trimming is to reduce the amount of feather and skin damage to birds from social and aggressive pecking. In untrimmed birds feather and skin damage can ultimately lead to cannibalism, which is greatly reduced in beak trimmed birds. The most common method of beak trimming in laying hens currently is hot blade (HB) trimming, a procedure that utilizes a heated guillotine style blade that cuts and cauterizes the beak tissue simultaneously. Recently, an alternative method of beak trimming has



been introduced, known as Infrared (IR) beak treatment. This procedure uses an IR laser, similar to those used in biomedical procedures. A short burst from the laser is focused on the beak tip which will erode away over the course of two weeks post-treatment. In this study we followed 60 production hens from 5 to 35 weeks of age. Half of these birds were beak trimmed using HB and the other half with IR. Our results suggest that IR beak treatment provides a useful alternative to conventional hot blade beak trimming in terms of chicken welfare by allowing birds to display more efficient feeding behavior with less morphological abnormalities of the beak stumps. The data from the present study can be used by farmers in management practices and other scientists when planning and conducting their studies.

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Departures....

Staci Weedman completed her M.S. studies in immunology and microbiology in pigs with Dr. Susan Eicher and Dr. Marcos Rostagno.

Matthew Horsman, a Research Technician accepted a job as a County Extension Agent for Williamson County in the University of Tennessee

system and moved in Feb. 2010.

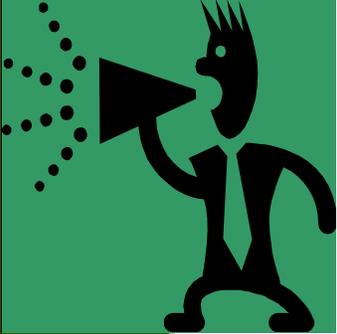
Erin Schenck, one of our M.S. graduates and then Research Technician, moved to a similar role at Mississippi State University.

Harold Parks, our Program Support Assistant left in Dec. 2009 to return to Georgia.

Sophia Wilcox left us in March 2010 after 8 years as one of our research technicians, to join Purdue University as a University Development Specialist in the College of Agriculture and has been posted to Kabul to help rebuild the agricultural industry in Afghanistan.



Invited Talks



Cheng, H.W. 2009. Invited Keynote speaker. "Breeding of Tomorrow's Chickens to Improve Well-Being". Keynote symposium. Poultry Science Association, Annual Meeting, Raleigh, NC.

Cheng, H.W. 2010. Invited presentation. "Pain in chickens and effects of beak trimming", American College of Poultry Veterinarians Workshop in conjunction with the Western Poultry Disease Conference, Vancouver, Canada.

Lay Jr., D. C. 2008. Animal Welfare and Stress: A historical perspective and its influence on animal productivity in the United States, Hangzhou University, China,

Lay Jr., D. C. 2009. USDA's Interest and Role in Farm Animal Welfare and Behavior. DLT Smith Visiting Scientist presentation University of Saskatchewan's Western College of Veterinary Medicine, Saskatchewan, Canada.

Lay Jr., D. C. and Garner, J. P. 2009. Making sense of fear testing – validating common behavioral tests used in swine. Invited presen-

tation at Joint Meeting of American Society of Animal Science and Canadian Society of Animal Science, Montreal, Canada.

Lay Jr., D. C. 2010. The Physiologic Response to Stress and its Effects on Swine Reproduction, Invited presentation at Billy Day Symposium at ASAS Mid-west ASAS meeting, Des Moines IA.

Marchant-Forde, J.N. and Marchant-Forde, R.M. 2008. Advances in the automatic collection of behavioural and physiological data. Invited plenary presentation at 42nd Congress of International Society for Applied Ethology, Dublin, Ireland.

Marchant-Forde, J.N. 2009. Behavior × nutrition interactions in swine. Invited presentation at Joint Meeting of American Society of Animal Science and Canadian Society of Animal Science, Montreal, Canada.

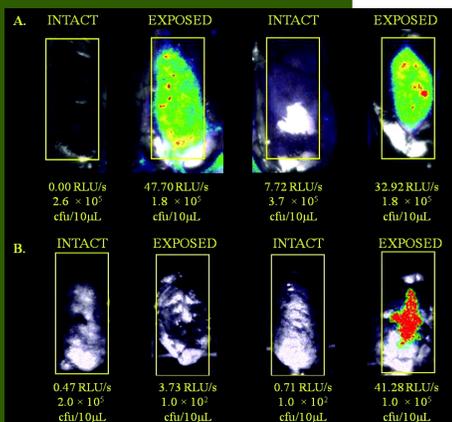
Rostagno, M.H. 2009. Organic Pork Production and Food Safety. Invited presentation at Institute of Food Technologists Annual Meeting, Anaheim, CA.

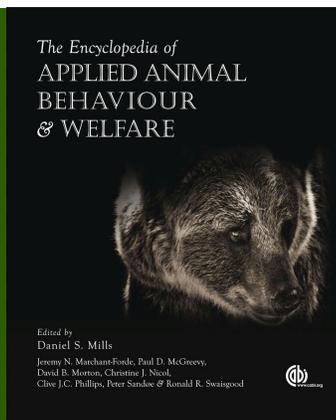
Glow-in-the-dark pigs?

Not really, but the bacteria inside them did! This study was conducted to monitor Salmonella progression by photonic detection through different segments of the gastrointestinal tract of swine following oral inoculation for the potential of creating a research model that may quantify bacterial invasion more quickly, efficiently, and definitively in the swine gastrointestinal tract. Researchers can better understand disease pathology, pharmacokinetics and other biomolecular processes taking place in the living animal by imaging the whole animal at multiple time points as opposed to euthanizing sub-sets of animals at various time points to collect tissues for analysis. This application can improve statistical quality of data because each experimental animal is its own statistical control and experimental variability can be reduced

by more rapid and computerized in vivo data collection using imaging technologies. The current study

was limited to a 12 h period of exposure. At the 12 h time-point, the concentration of bacteria and detected photonic emissions within intact and exposed segments were greater in two parts of the intestine than in other segments of the intestine. Our study determined that within 6 hours infection developed in the small intestine (duodenum, jejunum and ileum) with higher concentrations of bacteria than in the large intestine using standard microbiological techniques. When evaluated after an increased time (12 h) of incubation in swine, our study resulted in higher concentrations in the parts of the small intestine, than in the large intestine. However, from the use of bioluminescent Salmonella in our study, positive correlations between photonic emissions and bacterial concentrations were observed for exposed segments of intestine after 6 hours post-oral infection. This study perpetuates the idea that biophotonic techniques can improve development of bacterial pathogenicity models.





Reference Text Published

LBRU scientists played a major role in the editing and authorship of a new encyclopedia covering the topics of applied animal behavior and welfare. Under an editorial team of 8 editors, including Jeremy Marchant-Forde, The book contains over 900 entries, of which nearly 10% were written by LBRU members.

The 685-page volume contains a wealth of fully cross-referenced entries from concise definitions to detailed short essays on biologi-

cal, practical, clinical and ethical aspects of behaviour and welfare in domestic, exotic, companion and zoo animals.

Altogether, 13 current and former LBRU scientists and graduate researchers contributed to the encyclopedia and it is hoped that it will become an essential resource for practicing veterinarians, researchers and students in zoology and ethology, and to all those working with, and interested in, animals and their welfare.

Visitors



Dr. Heng-wei Cheng coordinates the Summer Research for Mainland Chinese and Taiwanese Students Program and has hosted 20 students in 2008, 11 students in 2009 and 11 students have been selected for 2010. The students work with faculty in Purdue Dept. of Animal Sciences with and LBRU scientists.

During the summer of 2009 **Feifei Yan** of Zhejiang University did an internship with

Dr. Cheng and **Yi Yang** also of Zhejiang University did an internship with Dr. Rostagno.

Leticia Gomes de Moraes, a DVM graduate, visited us from the Federal University of Lavras, Brazil between Dec. 2009 and May 2010. Working primarily with Dr. Marcos Rostagno on pre-harvest food safety projects, Leticia also helped with many of our other studies on farm and in the lab.

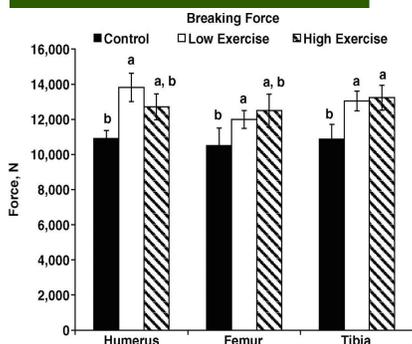
Dr. Angela Green, Assistant Professor at the University of Illinois at Urbana - Champaign, visited in Oct. 2009 and gave a Departmental Seminar entitled "An Engineering Perspective of Animal-Environment Interactions".

Prof. Don Broom, University of Cambridge, visited in Nov. 2009 and gave a Departmental Seminar entitled "The Welfare of the Dairy Cow".

Exercising sows has benefits

Sow lameness is one of the top three reasons for culling. In 2000, an estimated 64% of sows were housed in gestation crates in the U.S., which greatly restricts the type and amount of movement a sow can perform. Muscular strength is less in crated sows compared to group-housed sows, affecting ability to move with ease and sit up and lie down. The number of sows kept in gestation crates has increased over the past 15 years and during that same time period there has been a 10% increase in the number of piglet deaths due to crushing. If exercise can improve sow agility, she may be able to control the descent of her body better and crush fewer piglets. Our study examined whether exercise contributed to a decrease in occurrence and severity of lameness, improved the ease of lying down, and affected measures

such as litter size and number of piglets weaned. We found that exercise had no effect on lameness, interbirth intervals, or muscle mass, but did improve bone density and breaking strength and the number of piglets weaned compared to non-exercised sows. Non-exercised sows took longer to lie down compared to the exercised sows. The difference in lying times may have caused the differences in the number of piglets weaned and percent of piglets lost in that in taking too much time to lie down allows for piglets to have more time to get underneath the sow, increasing the risk of crushing. By developing housing systems that promote exercise, producers may be able to increase the number of piglets weaned and thus increase profits even when confinement housing sows during parturition and lactation.



Bone strength increased

Recent Publications



Bearson, B.L., Bearson, S.M.D., Uthe, J.J., Dowd, S.E., Houghton, J.O., Lee, I.S., **Toscano, M.J., Lay, D.C.** 2008. Iron regulated genes of *Salmonella enterica* serovar Typhimurium in response to norepinephrine and the requirement of fepDGC for norepinephrine-enhanced growth. *Microbes and Infection*, **10**:807-816.

Bewley, J.M., Boyce, R.E., Hockin, J., Munksgaard, L., **Eicher, S.D., Einstein, M.E., Schutz, M.M.** 2010. Influence of milk yield, stage of lactation, and body condition on dairy cattle lying behaviour measured using an automated activity monitoring sensor. *Journal of Dairy Research*, **77**:1-6.

Cheng, H.W. 2010. Breeding of tomorrow's chickens to improve well-being. *Poultry Science*, **89**:805-813.

Cheng, H.W., Fahey, A. 2009. Effects of group size and repeated social disruption on the serotonergic and dopaminergic systems in two genetic lines of White Leghorn laying hens. *Poultry Science*, **88**:2018-2025.

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Eicher, S.D., Wesley, I.V., Sharma, V.K., Johnson, T.R. 2010. Yeast cell-wall products containing beta-glucan plus ascorbic acid affect neonatal *Bos taurus* calf leukocytes and growth after a transport stressor. *Journal of Animal Science*, **88**:1195-1203.

Fahey, A.G., Cheng, H.W. 2008. Group Size and Density Effects on Physical Indices and Cell-Mediated Immunity in Two Genetic Lines of White Leghorn Layers. *Poultry Science* **87**:2500-2504.

Fahey, A.G., Cheng, H.W. 2008. Effects of social disruption on physical parameters, corticosterone concentrations, and immune system in two genetic lines of white leghorn layers. *Poultry Science*, **87**:1947-1954.

Love, B.C., **Rostagno, M.H.** 2008. Comparison of five culture methods for *Salmonella* isolation from swine fecal samples of known infection status. *Journal of Veterinary Diagnostic Investigation*, **20**:620-624.

Marchant-Forde, J.N., Lay, D.C., Marchant-Forde, R.M., McMunn, K.A., Richert, B.T. 2008. The effects of R-salbutamol on behavior and physiology of finishing pigs. *Journal of Animal Science*, **86**:3110-3124.

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Marchant-Forde, R.M., Fahey, A.G., Cheng, H.W. 2008. Comparative effects of infrared and one-third hot-blade trimming on beak topography, behavior, and growth. *Poultry Science*, **87**:1474-1483.

Moulton, K., Ryan, P., **Lay Jr., D.C.** and Willard, S. 2009. Photonic plasmid stability of transformed *Salmonella typhimurium*: A comparison of three unique plasmids. *BMC Microbiology*, **9**:152.

Moulton, K., Ryan, P., **Lay Jr., D.C.** and Willard, S. 2009. Post-mortem photonic imaging of lux-modified *Salmonella Typhimurium* within the gastrointestinal tract of swine after oral inoculation in vivo. *Journal of Animal Science* **87**:2239-2244.

O'Driscoll, K.K.M., Schutz, M.M., Lossie, A.C., **Eicher, S.D.** 2009. The effect of floor surface on dairy cow immune function and locomotion score. *Journal of Dairy Science*, **92**:4249-4261.

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Poletto, R., Rostagno, M.H., Richert, B.T., Marchant-Forde, J.N. 2009. Effects of a "step-up" ractopamine feeding program, sex, and social rank on growth performance, hoof lesions, and *Enterobacteriaceae* shedding in finishing pigs. *Journal of Animal Science*, **87**:304-313.

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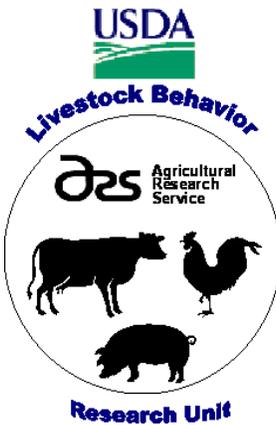
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Schenck, E.L., McMunn, K.A., Rosenstein, D.S., Strohshine, R.L., Nielsen, B.D., Richert, B.T., Marchant-Forde, J.N., Lay, D.C. 2008. Exercising stall-housed gestating gilts: Effects on lameness, the musculo-skeletal system, production, and behavior. *Journal of Animal Science* **86**:3166-3180.

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The mission of the LBRU is to develop scientific measures of animal well-being, through the study of animal behavior, stress physiology, immunology, neuro-physiology, and cognition, that will allow an objective evaluation of animal agricultural practices. This method of study will allow the improvement of existing practices and invention of new practices that can enhance animal well-being and increase animal productivity. In addition, this unit will use and develop its knowledge of stress physiology and animal behavior to address concerns of pathogen contamination of livestock carcasses due to the stress of handling and transportation. The optimization of animal well-being will assist in improving animal health, increasing productivity and decreasing human exposure to dangerous pathogens.

USDA is an equal opportunity provider,
employer and lender.

**Finding solutions to
agricultural challenges**



Out & About - disseminating LBRU research



LBRU scientists attended and presented at the following conferences:

- 42nd Congress of the International Society for Applied Ethology, Dublin, Ireland. Aug.2008.
- W-1173 research committee on Stress Factors of Farm Animals, Colorado State University CO, August 2008.
- NE-1022 research committee on Poultry Production Systems, Atlanta GA, Oct. 2008.
- Society for Neuroscience, Washington DC, Oct. 2008.
- Conference of Research Workers in Animal Disease, Chicago IL, Dec. 2008.
- American Association of Swine Veterinarians, Dallas TX, March 2009.
- NC-1029 research committee on Applied Animal Behavior & Welfare, Michigan State University MI, May 2009.
- International Symposium on Foodborne Pathogens in Pork, Netherlands, May 2009.
- 43rd Congress of the International Society for Applied Ethology, Cairns, Australia. July 2009.
- Poultry Science Association. Raleigh NC, July 2009.
- Joint Annual Meeting of the American Society of Animal Science, American Dairy Science Association and the Canadian Society of Animal Science, Montreal, Canada, July 2009.
- North American Regional Meeting of the International Society for Applied Ethology, Montreal, Canada. July 2009.
- W-1173 research committee on Stress Factors of Farm Animals, University of Missouri - Columbia MO, August 2009.
- NE-1022 research committee on Poultry Production Systems, Mystic, CT. Oct.2009.
- Society for Neuroscience, Chicago IL, Oct. 2009.
- Society for Leukocyte Biology, Denver CO, Nov. 2009

